planning guidelines for residential and path development in michigan's

SAND DUNES & WETLANDS

michigan's coastal zone management program

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why sand dunes and wetlands are important

The sand dunes and wetlands of Michigan's Great Lakes shores are among the State's most significant natural resources. The dunes are unique geological forms. They and their vegetation are important for landscape, recreation, scientific, educational, and economic values. The wetlands play unique roles in their intermediate position between the Lakes and more inland areas, providing feeding, nesting, and resting habitats for fish, wildfowl, and other wildlife forms, buffer areas for high water and storm floods, a natural filter for the benefit of water quality, and like the dunes, landscape, recreation, scientific, and educational opportunities.

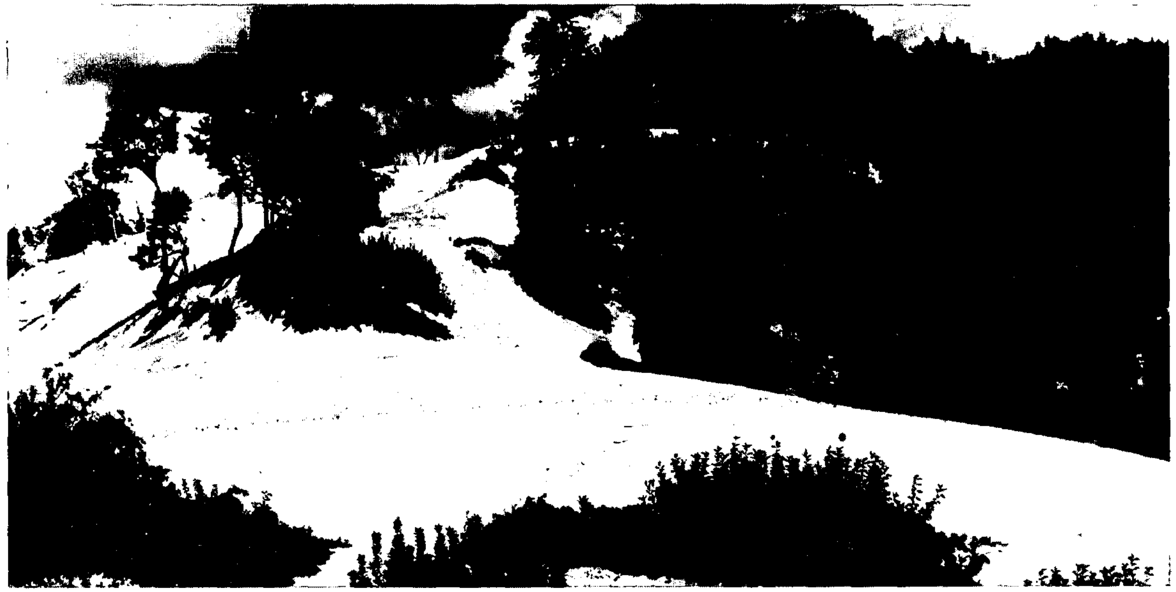
Ideally, Michigan's remaining undeveloped sand dunes and wetlands should remain wholly open--in this way they can be used and reused indefinitely by local residents and visitors. As a matter of fact, however, land development continues and will continue throughout Michigan's shorelands. A few simple ecological planning and design principles and a good measure of common sense can go a long way towards assuring that where development occurs, the valuable characteristics of dunes and wetlands will be retained and protected to the greatest possible extent. The dunes and wetlands of Michigan's shorelands are too important as resources to be squandered by ill-planned, poorly designed, and badly constructed development.

At the present time, about 64 Percent or 1,480 miles of Michigan's 2,322 miles of mainland shoreland are still undeveloped. Parts of the 36 percent already developed are subject to serious problems affecting the public health, safety, and welfare. Houses are falling into Lake Michigan, homes are being flooded on Lake Erie. Private property and human life are endangered. Where such mistakes occur, the ruination of the shore precludes opportunities for future use by owners as well as neighbors.

More dunes and wetlands will undoubtedly be developed in the future, especially in the absence of more restrictive land-use controls. The most important long range result, of course, will be the actual reduction in area of Michigan's dune and wetland resources, and the dimunition of their contributions to a stable ecology and to recreational, wildlife, and aesthetic benefits. The immediate impact on the communities and residents of Michigan's shorelands is the continuing threat to human health and safety which poor site planning, design, and construction engender in or near sand dunes and wetlands.

With the real prospect of increased seasonal and year-round residential use of the shorelands, local and county officials, as well as private landowners and citizens, must play a more active planning role. Ultimately it is they who will determine how Michigan's special shoreland resources are protected in the context of legitimate residential and recreational use of sand dunes and wetlands.

Sand dunes can be put to a variety of uses. Some work better than others.



a recreational area left in its natural state

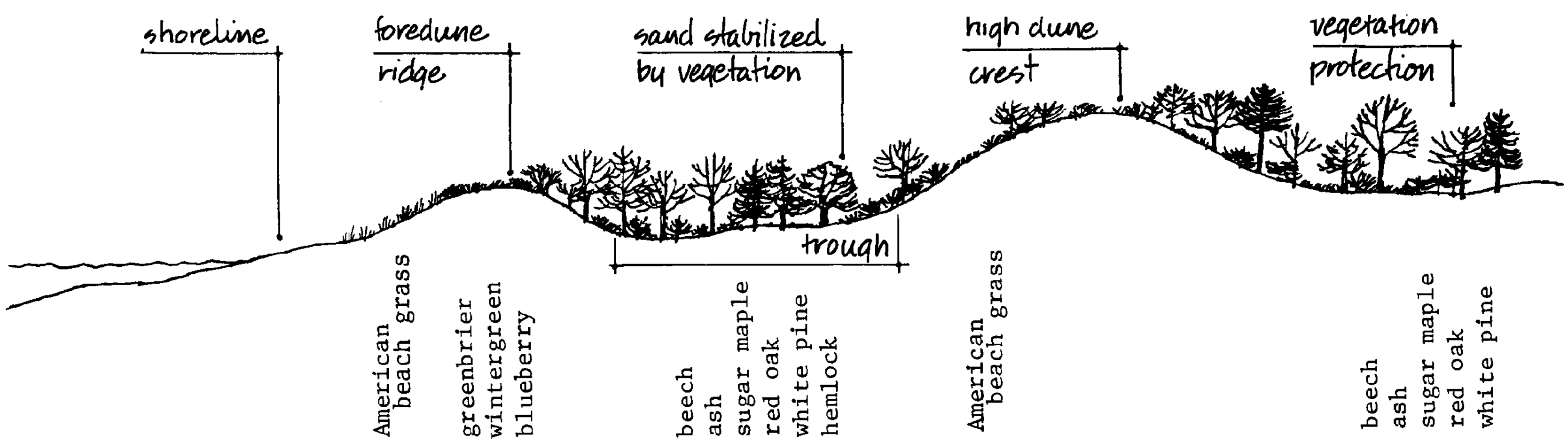
a home sited too closely to the shoreline

sand dunes 1

SAND DUNES

Michigan's sand dunes are located largely in the western part of the state on Lake Michigan, from the Indiana state line north to Traverse Bay and the Straits of Mackinac. To a more limited extent, they are also found in the Upper Peninsula on Lake Superior and on Lake Huron in the eastern part of the state.

Sand dunes constitute complex and dynamic natural systems. They are constantly being formed and transformed by wind action, and are in turn eroded away by storms and wave action. The longer-term factors of fluctuations in lake level and climatic cycles also affect dune formation and reduction. Sand dunes are thus in an almost constant process of change, mostly imperceptible to the casual observer--and often surprising to the unwary.



Coastal dunes in Michigan fall into two basic types: foredune ridges and high dunes. The latter are relatively higher in elevation and older in age and are situated generally farther away from the shoreline. In a natural state, the foredunes are stabilized by beach grass and other ground covers tolerant to exposed conditions, while the more protected high dunes are covered by successions of vegetation climaxing in mixed hardwoods.

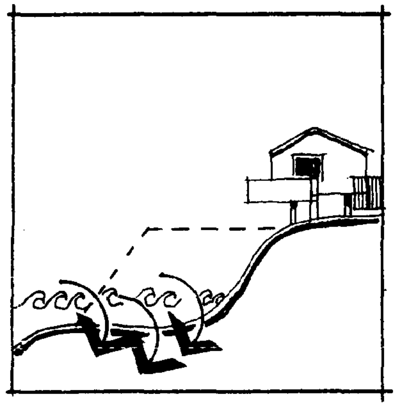
If vegetation is destroyed by natural disturbances such as fire, drought, and disease, or by man-made development and human activity, wind is free to erode, move sand, and create local changes in dune form. Ultimately, whole dunes may move or "migrate."

The first changes that occur with loss of vegetation and sand disturbance are the flattening of dune crests and the creation of blow-outs, or wind-formed gullies. Blowouts may take on extensive U-shaped or clustered forms, greatly modifying original crest lines into quite irregular, often sinuous shapes. Inland movement of dunes often results from such extensive wind erosion, although the rate of migration rarely exceeds a rate of five feet per year. Since the velocity of onshore winds decreases with distance inland and since upland vegetation tends to trap wind-blown sand, few of the coastal dune systems of Michigan extend further inland than one-half mile.

problems and challenges

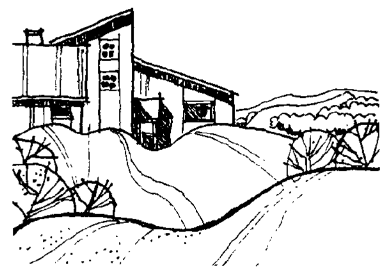
If man is not very careful in planning, designing, constructing, and maintaining residential structures and access ways in shoreland sand dunes, difficulties are liable to show up, and show up quickly. Some of the more critical problems:

undercutting and eventual collapse of structures into Lake waters



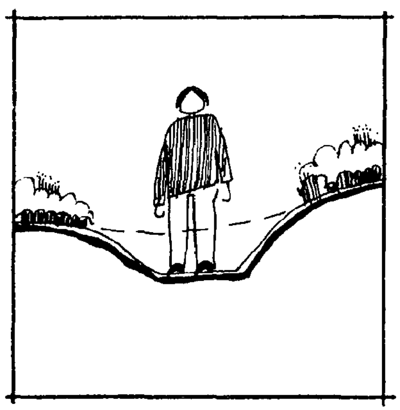
wind-blown sand covering roads, paths, and trails

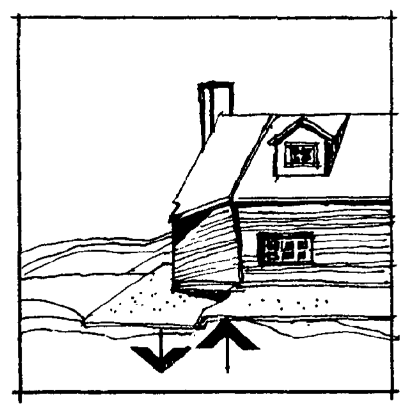
removal of dune crests and vegetation (in order to "improve" the site and view)



moving dunes covering structures and trees

indiscriminate trampling of dunes by residents and recreationists, leading to loss of vegetation and to blow-outs

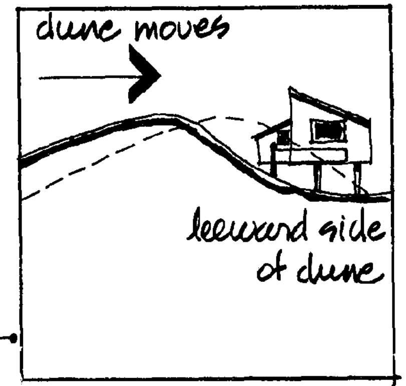




cracking of foundations, slabs, and roads destruction of vegetation during construction of structures and roads

pollution of surface and ground water from on-site sewage disposal systems

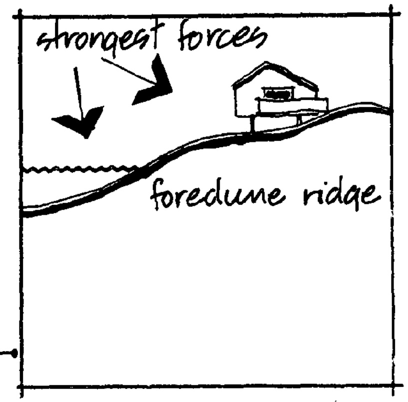
sand, wind, and storm damage to residential structures



avoid sites inland from moving dunes

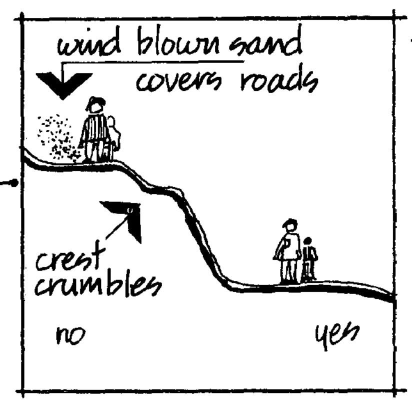
In order to avoid such problems, and the undesirable effects which they directly or indirectly cause, a number of development constraints should be carefully followed:

residential development should ideally be sited inland away from the (average maximum) one-half mile wide, coastal dune system; the inland or leeward side of moving dunes should be avoided as a site for all structures and access ways



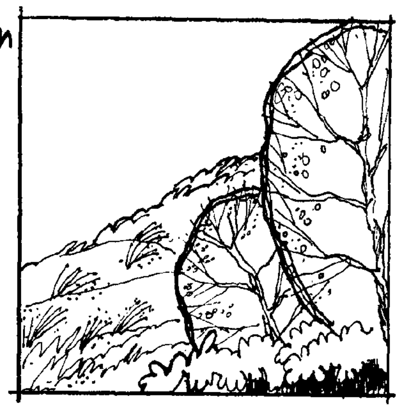
the windward side of the foredune ridge should remain unbuilt

the lake or windward side of the foredune ridge is the most fragile portion of the coastal dunes system, and should therefore be especially avoided as a site for residential structures and roads; limited access ways for beach-goers are acceptable



footpaths should be carefully sited

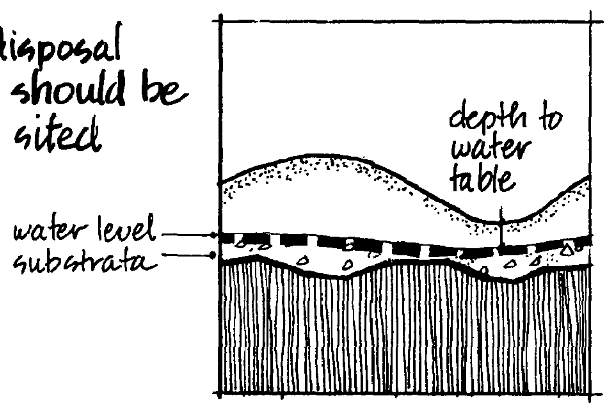
leave dune vegetation in a natural state



all dune vegetation should be left as unaltered as possible before, during, and after construction of structures and access ways; this constraint is particularly applicable to the beach grass and other ground cover found on the windward, more exposed side of the foredune

access between the inland residential sites and the shore should be accommodated on dune-compatible paths and trails; the trough behind the foredune ridge, as well as other natural, low-lying passageways through the dunes system, should be utilized for roads, pathways, and trails

sewage disposal systems should be carefully sited



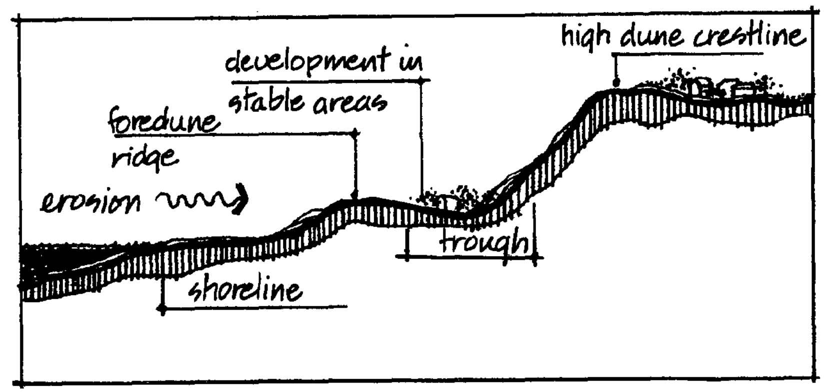
conversely, such low-lying areas should be avoided as sites for all sewage disposal systems due to their relatively close proximity to the ground water table and because percolation rates of effluents through sandy soils are relatively high

planning with dunes in mind

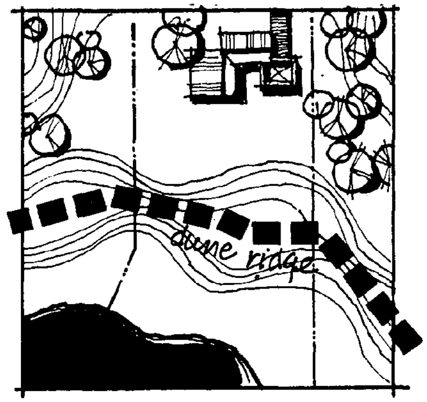
1) location of development within the shorelands

From a large-scale, long-range, and public resource perspective, as well as from the property-owner's long-range self-interest, residential development should not take place within the shoreland dunes at all. Reasonable arguments from a public health, safety, and welfare are recognized by most people. The potential harm which results from building houses and roads too close to the shoreline has been mentioned. Pollution of both surface and ground water can result from residential development in the dune system. Moving sand dunes have been known to engulf structures and access ways. Residential development should therefore be located, to the greatest degree possible, outside of the coastal dune system.

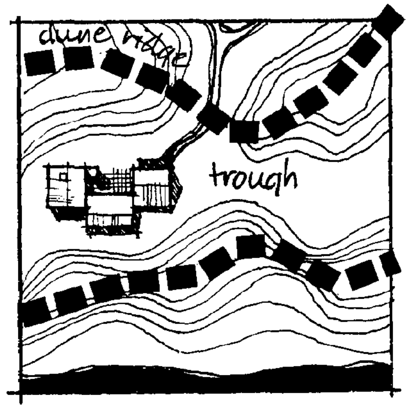
In the absence of legal regulations or voluntary actions towards this planning objective, the problems associated with development in the shoreland dunes must be approached with the greatest care and attention given to the ecological and landscape constraints of the specific site.



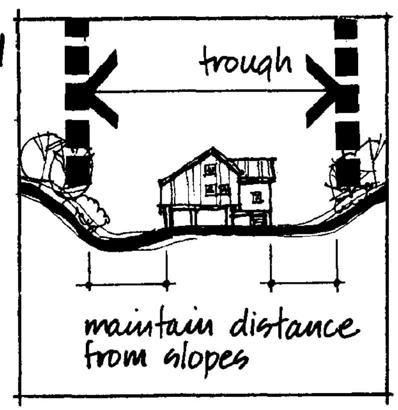
home sited on back of lot, away from lake and foredune ridge



residential development located in trough; road sited in natural swale



site structure away from slopes



2) location of development within the dune system

The foredune ridge should be left entirely clear of both residential structures and roads. Lots for residential use should be laid out in areas where vegetation has stabilized the dunes, away from the dune crests and blow-out areas. Lots intended for non-residential use, such as for open space and passive recreation purposes, can be laid out in the less stable, less vegetated areas of the dunes, if adequate precautions are provided for dune protection.

Recreational paths and trails should not be located along the dune face between the foredune ridge and the shoreline. Instead, they should be laid out parallel to the shore within the small valley or trough between the foredune ridge and the high dune crestline further inland. (Special construction techniques are recommended in a later section for getting from the trough over the dunes to the shore.)

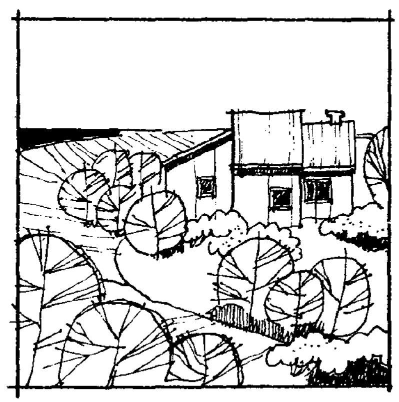
Relatively low density residential development, such as single-family units either on individual lots or clustered together, can be located within the trough between the foredunes and the high dunes, provided there is sufficient level space between dune slopes or if raised structures are developed. (See section on construction techniques.) If either of the latter two conditions cannot be met, then such low density residential development should be located further inland, behind the crestline and back-slopes of the high dunes.

3) protection of sand dune vegetation

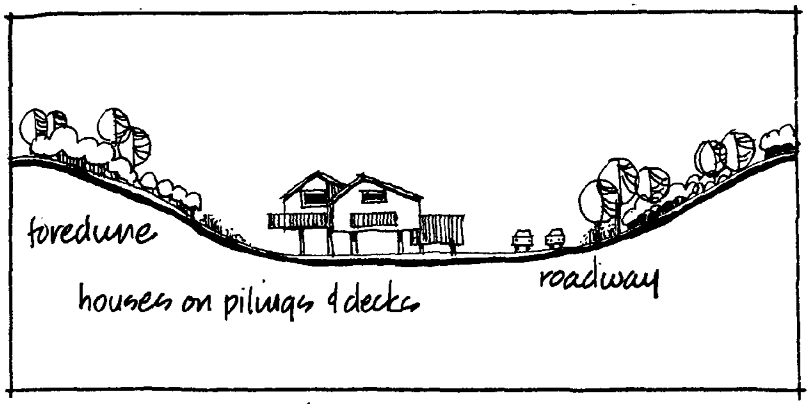
On the leeward or inland side of the foredune ridge, away from more direct exposure to wind, wave, and storm action, vegetation enjoys a more tolerant environment than on the windward or Lake side. Behind the crestline of the high dunes, vegetation is even more established. Vegetation is the key natural element in the stabilization and maturation of sand dunes.

Without vegetation, the Michigan sand dunes would be a wind-swept, desert wasteland. A native forest of mixed hardwoods, including beech, ash, sugar maple, red oak, white pine, and hemlock, has continued to cover generally both the leeward side of the foredune ridge and the high dunes located further inland. Shrubs and groundcover, including greenbrier, wintergreen, and blueberry, are also prominent throughout the coastal dune system. The most tolerant of the dune species, American beach grass, is the natural stabilizer of the more exposed side of the foredune ridge. All of these types and species of vegetation perform the crucial functions of stabilizing sand, mitigating the effects of wind action, providing wildlife habitat, and creating visual variety in the shorelands landscape.

All dune vegetation should therefore be left as unaltered as possible before, during, and after the construction of residential structures and access ways; the development of recreational path and trail systems should also leave vegetation in its natural state as much as possible. Where vegetation is lost, it should be carefully restored. (See maintenance considerations.)

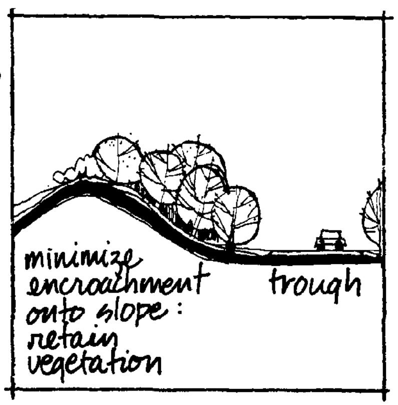


native vegetation on home sites



place houses back from foredune up on structures when the possibility of dune movement exists; place roads even further back.

site roads in natural passageways



handling design

1) siting of structures behind crestlines

New residential structures should be sited behind dune crestlines in the leeward, wind-protected areas. Vegetation tends to be more mature and its stabilizing effect more pronounced there. Within a subdivision lot which contains dune slopes or vegetation, the structure itself should be located in the portion of the lot as far away as possible from these sensitive areas. The amount and quality of existing vegetation, as well as the number and location of blow-outs, should be primary site considerations. In no case should the natural topography of the dune crest be altered. Raised deck structures on piles will permit the retention and continued existence of shrubs and ground cover beneath at least some of the structure and will allow a return to natural grade of disturbed surfaces. (See section on construction techniques.)

2) siting of roads in natural passageways

Roads should be sited behind the high dunes, in the trough behind the foredune ridge, and through other natural gaps within the dune system. Major subdivision roads or collectors should be laid out parallel to and away from dune crests and away from sand slopes to the greatest possible extent. Minor subdivision roads and driveways may be laid out perpendicular to dune crestlines within sufficiently wide natural gaps through the dunes, but in no case should they extend into or over the foredune ridge or onto the crest of the high dunes. Dune topography and vegetation, especially at or near the crestlines, should be carefully preserved wherever roads are built.

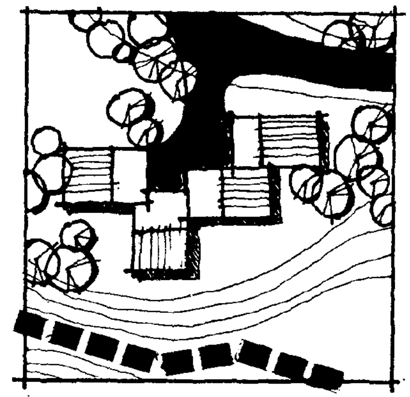
3) siting of pathways and trails

Pathways and trails for non-vehicular traffic should also be sited primarily in the trough behind the foredune ridge. They should cross both foredune ridge and high dune crestline only where natural gaps, swales, or low-points exist, or on raised boardwalks where they do not. The concept is to raise the boardwalk above the natural slope of the dune in step-like fashion. In this way, neither dune topography nor vegetation are destroyed, and if they are disturbed, such man-made disturbances are kept minimal so that disastrous blow-outs do not develop. (See section on construction techniques.)


use of natural openings for paths and trails

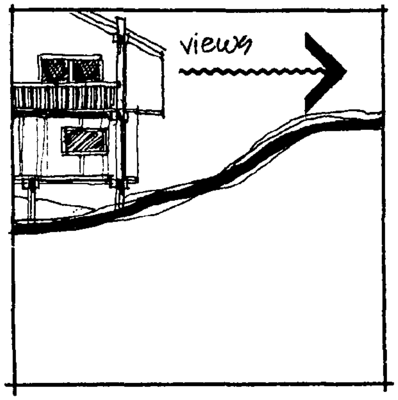
4) clustering site development

The grouping together of single-family housing units is currently a popular alternative to conventional zoning and subdivision development. The clustering of residential structures is commonly used to lower the cost of providing driveways, parking space, and other public and private utilities. Cluster development is especially appropriate within a well-protected vegetated area behind the foredune ridge, where flat terrain is relatively abundant. Views of the water and exposure to the cooling summer breezes may be improved through raised structures. (See section on construction techniques.) Moreover, where standard subdivision lots are too small to permit sound site planning and the laying out of structures at a sufficiently compatible distance from foredunes or high dune crests, owners should investigate landowner association and similar resource management arrangements to permit the shared use of land and the construction of several houses in cluster fashion on a suitable site.


clustered development

building in dune areas

1) raised residential structures

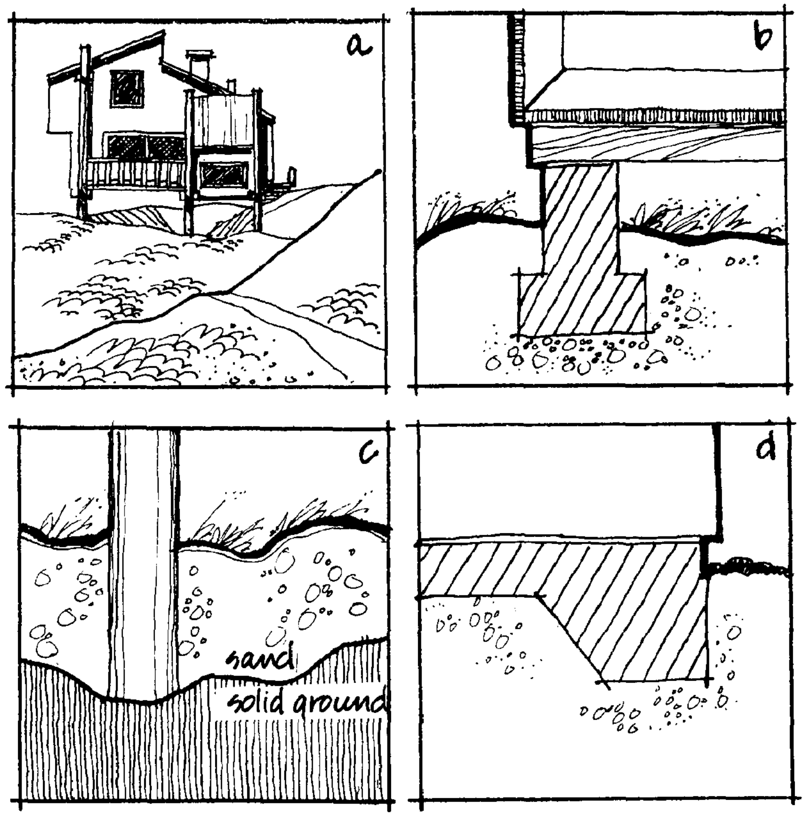


raised structures protect dune, provide views

Raised construction on either wood pilings or concrete columns on piers is strongly recommended for sites with little or no vegetation. Dune sites of minimal vegetation are generally wind-blown and unstable, and elevated structures are generally free from the problems associated with residences built at ground level, such as cracked foundations and infiltration of blown sand. Equally important, dune grass, ground cover, and low shrubs are allowed to survive or re-establish themselves beneath the edges of the building, thus offering further control over sand erosion and dune disturbance. In addition, raised structures afford views over dune topography not otherwise available at ground level.

2) footings and foundations

In all cases, footings and foundations should extend to solid ground below the frost line. Where the sand is of an indeterminate depth or solid ground too deep for pilings, spread footings are recommended. Raft footings can be used to float a structure on top of or just below the surface of the sand. Such a construction technique is combined with a slab foundation in order to avoid the problem of maintaining basements in sand dunes. In general, basements are <u>not</u> recommended because of a tendency to crack when sand moves below ground level.



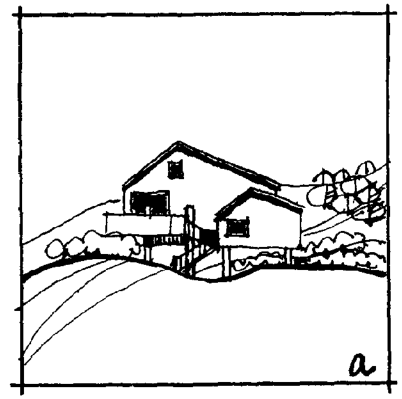
a pilings to protect vegetation and slopes
b spread footings
c pile footings extend to solid ground
d raft footings

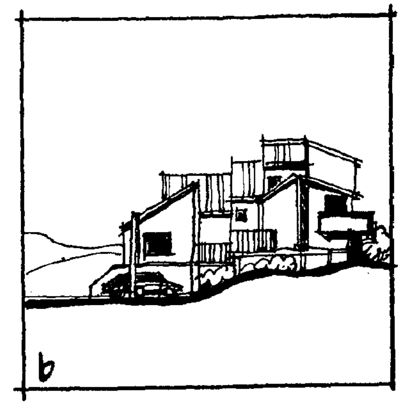
3) raised platforms for residential clusters

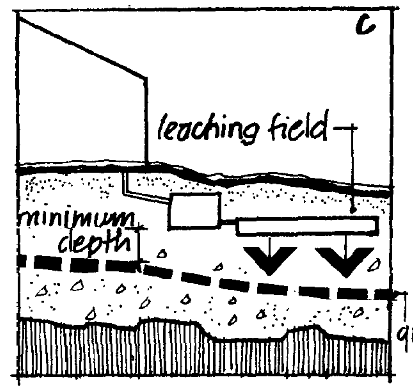
A previous design consideration recommended the clustering of single-family dwellings in appropriate situations. Depending upon the number and density of units in a particular development, platform construction is recommended in order to cluster elevated structures in an aesthetically pleasing and utilitarian manner. Utilities and other accessory uses can sometimes be appropriately accommodated underneath such platforms, but they should be properly screened from view by wood siding; in any event, care must be taken as always to minimize adverse impacts on dune topography and vegetation. Townhouse or apartment-type dwellings may be a necessary prerequisite to provide greater economic feasibility and a tighter density in the design and construction of platforms. If this is the case, then such relatively high density residential development should be located as far away from the fragile shoreline area as possible, preferably behind the high dune crestline.

4) utility systems (sewage disposal)

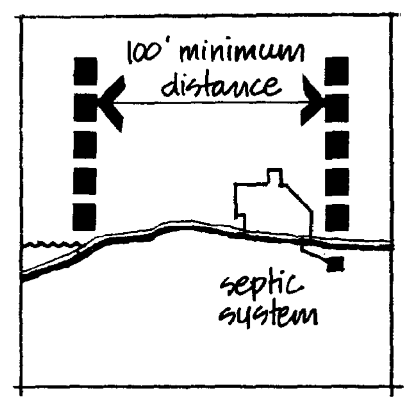
Standards for the installation of water and sewage disposal systems are found in local and county subdivision rules and regulations, sanitary codes, and building codes. As a rule of thumb, increased minimum standards should be applied to the distance separating on-site sewage disposal systems from wells, streams, and water bodies. This is because sand dunes are very permeable, with rapid percolation rates; sanitary waste effluents need sufficient depth of soil to become biologically purified before reaching water supplies or the ground water table. For example, in county health codes commonly quoted minimum distances to isolate septic tanks and leaching fields from wells or streams are 50 to 75 feet and



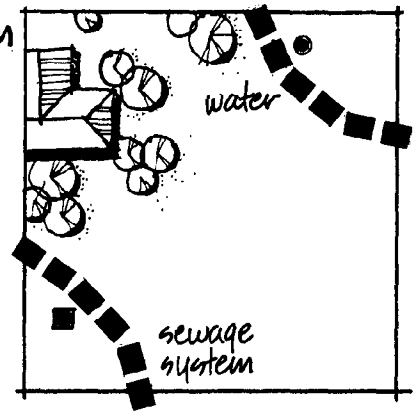




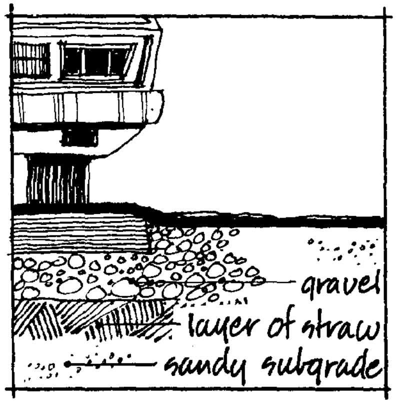
a houses on pilings and decks
b raised platforms for residential clusters
c sand percolation



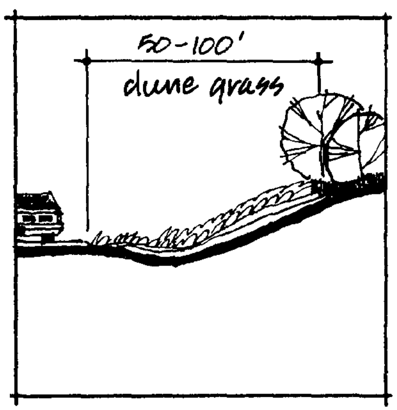
increased minimum distance to open water increased minimum distance between sewage disposal unit and well



road construction



plantings on road shoulders



25 to 50 feet respectively. At least 100 to 150 feet should separate all sewage disposal systems from private wells and bodies of water. (See further information in wetlands construction section.)

It is recommended that for aesthetic reasons, all utilities be placed in underground conduits in new residential developments. Telephone and other overhead lines are sometimes blown over in severe storms, so there is also a practical side to this recommendation.

5) road foundations

Roads constructed in sand dunes should have no serious drainage problem, since sandy soils exhibit excellent drainage characteristics. After a sub-grade is completed and sideboards placed, it is recommended that a layer of hay or straw be spread over the sandy sub-grade. The purpose of such a layer is to keep the gravel from working into the sandy sub-grade before it is thoroughly packed down. For constructing non-paved roads, it is further recommended that a good road gravel be placed on the layer of hay or straw to a depth of eight inches on the sides and ten inches in the middle or crown.

For good maintenance, it is recommended on both paved and non-paved dune roads to plant dune grass some fifty to one hundred fifty feet on the shoulders, particularly the side from which the prevailing wind comes, in order to keep blown sand off the road and thereby keep down maintenance costs.

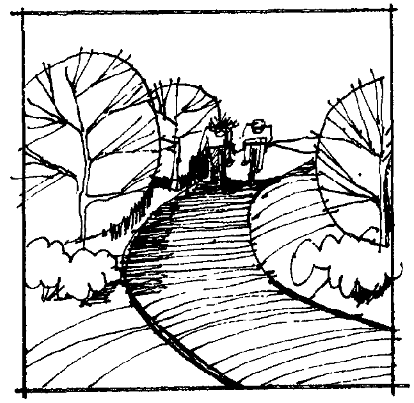
6) bikeways

As in other site situations, bikeways constructed in sand dunes should be paved with a smooth surface:

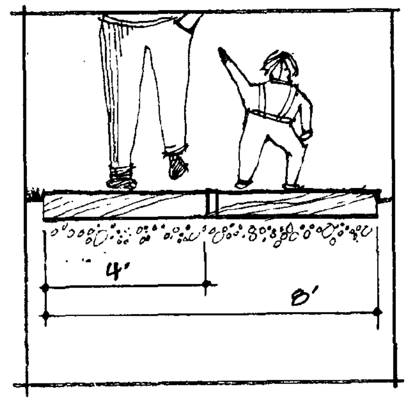
loose gravel and crushed stone can cause skidding. A two-way bicycle path should be at least 8 feet wide, with one-way paths a minimum of 6 feet wide. Grades should generally not exceed 5% in normal terrain, and a 15% uphill grade for short distances only should be considered as a maximum. Approximately 1 to 2 inches of concentrated asphalt surface is recommended, with the standard 4 to 6 inches of aggregate base not necessary in sandy soils due to generally excellent drainage; however, some sort of compact subgrade is needed.

7) boardwalks

Pedestrian boardwalks may be constructed in two ways: both are recommended. Method 1: three- to four-foot long boards are wired together about 1 inch apart in 10-foot sections; these 3- to 4-foot wide boardwalks can then be rolled up and moved depending upon specific site requirements. Pairs of sections can be laid together on the sand to form a six- to eight-foot wide boardwalk where needed. Method 2: eight- to ten-foot long planks totalling about 4 feet wide are cross-tied at each end, and angled for specific topographic and grade conditions. These planks run parallel to the direction of foot traffic, whereas the boards described above are perpendicular to travel.



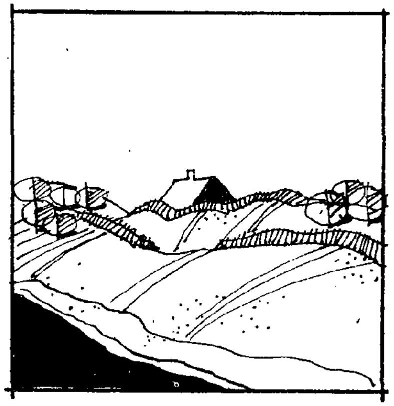
paved bike paths



moveable boardwalks

plank-sectioned boardwalk

snow fencing helps
beach grass
stabilize dunes



More generally, boardwalks can and should be constructed in elevated step-like fashion in order to provide pedestrian access over sensitive dune crests without disturbing either the topography or vegetation. Such elevated boardwalks, in conjunction with well-sited and constructed pathways and trails, are recommended for adequate recreational circulation and access to the lakeshore without environmental degradation.

8) planting vegetation and sand fencing

American beach grass (Ammophila breviligulata Fernald) is the best species for initiating the stabilization of sand dunes. Beach grass should be planted in strips parallel to the shoreline. The width of strips can vary from 15 to 100 feet depending on the amount of sand available for dune building. The species spreads by growing underground stems or runners which in turn form new plants. It can accumulate up to four feet of sand in a year's time. This perennial, native grass can tolerate sand blasting and deposition, strong winds, occasional flooding, and droughty, infertile sand. The planting of beach grass is thus recommended as a simple and relatively inexpensive maintenance technique for stabilizing dunes.

Standard wooden snow fencing is recommended for collecting wind-blown sand for building dunes. It may also be used to trap sand before it encroaches upon parking lots, roads, and ponds. In general, fences erected parallel to the shoreline can do an adequate job; however, fences can be placed at right angles to the shoreline to trap sand that blows up and down the beach.

wetlands 2

wetland areas store
surface and groundwater

filling them
in can jeopardize
life and property

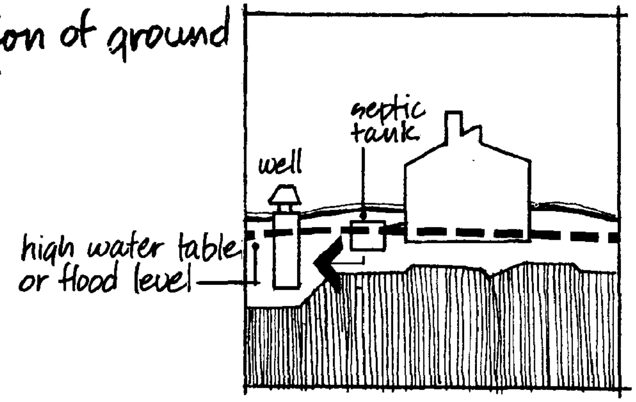
WETLANDS

Shoreland wetlands most subject to development pressures are found mainly along the southeastern and eastern coasts of Michigan on Lake Erie, Lake St. Clair, and the Saginaw Bay portion of Lake Huron. The wetlands on Lake Erie between Detroit and Toledo, Ohio are located in a more highly urbanized area than those found further north.

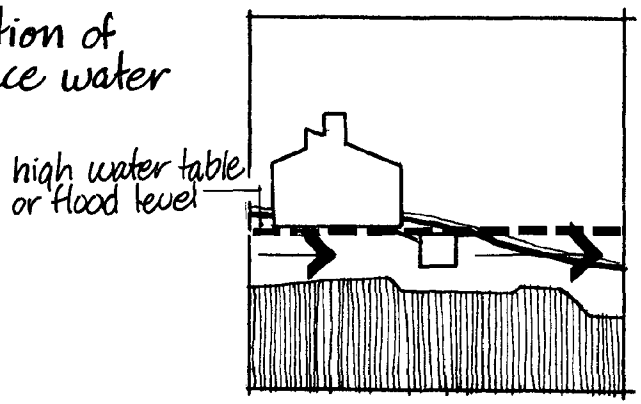
Michigan's shoreland wetlands are associated geologically and hydrologically with the levels of the Great Lakes, both in historical terms and as a continuation of the existing ground water table. Seasonal fluctuations of the water table are the result of seasonal cycles of weather and climate.

Productive coastal wetlands contribute greatly to Michigan's fish and wildlife resources. Important species of Great Lakes fish, waterfowl and marsh birds, small mammals, and amphibians and reptiles are directly dependent upon wetlands for shelter, food, and water. Wetlands vegetation provides visual and species diversity in the natural landscape, and serves as a counter-point to other types of land cover and land uses.

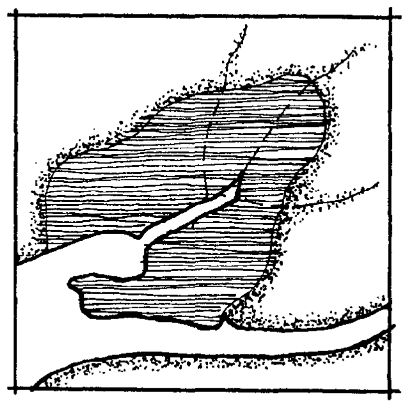
Wetland areas also serve as storage space for normal runoff and flood waters. The flood prevention function of low-lying coastal areas becomes dramatically evident when former wetlands filled for residential development are inundated as a result of above-normal precipitation and lake levels, often intensified by high waves and winds during storms. The public cost alone for flood damage on Michigan's pollution of ground water



pollution of surface water



wetland provides habitat and food sources for fish, game, and bird species



Great Lakes for the year from November 1972 to November 1973 was nearly $47 million. During that same 12-month period on two separate occasions, over 12,000 people were evacuated due to flood conditions.

problems and challenges

Serious problems are likely to occur in the absence of sensible planning, design, construction, and maintenance measures for residential development in or near wetland areas. Some of the more critical problems are:

destruction of homes and personal property due to inundation by flood waters

damage to structures, roads, and utilities caused by flooding

ground water contamination, leading to pollution of wells

pollution of surface waters, including existing water bodies and courses, and storm or flood waters

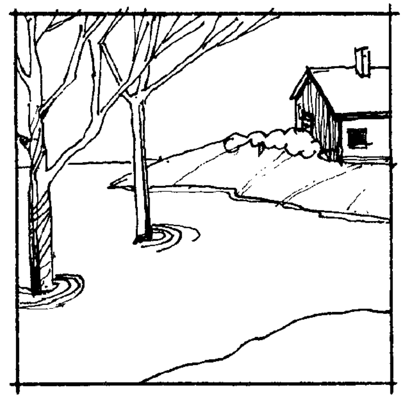
destruction of valuable fish and wildlife habitat

In order to avoid such problems and their undesirable effects, certain development constraints should be adhered to:

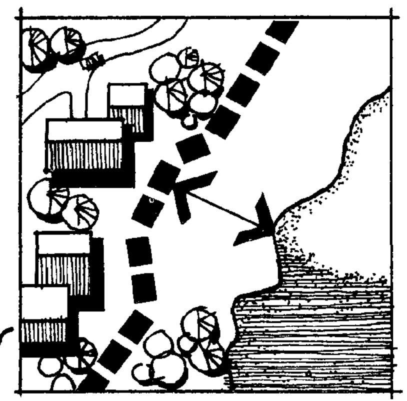
structures, access ways, and sewage disposal systems should be set safely above the seasonal high water table in order to avoid flooding and pollution problems

structures, access ways, and sewage disposal systems should be set safely back from the Lake shore, and from other water bodies or courses, in order to avoid flood water levels

wetland vegetation, soils, and hydrology should not be altered by dredging or filling in order that the water retention and ecologically productive functions of wetlands will not be diminished



site houses above flood waters



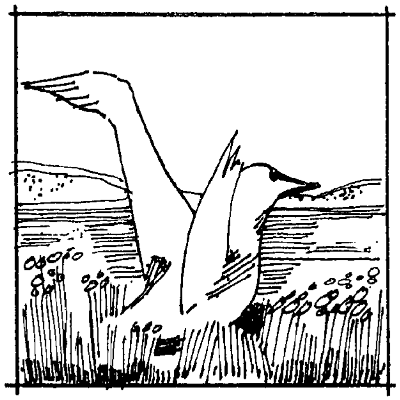
site houses back from open waters

what to plan for in wetlands

1) set back of all development from open water

From a broad public policy and resource planning perspective, as well as from the land-owner's long-range point of view, residential development should not take place within shoreland wetlands at all. Public health, safety, and welfare considerations are reasonable and are therefore appreciated by most people. Pollution, flooding, and general inconvenience are critical development problems. In the absence of comprehensive land-use regulations, public acquisition of shoreland wetlands, or private gifts of such land, all residential development should be set back a reasonably safe distance from both the lake shore and from other water bodies and courses as well as from periodically flooded lands.

wildlife habitats need protection



2) elevation of all development above ground water table

More important even than the recommended minimum set-back of all development from open water is the issue of elevating structures, roads, and other uses above the ground water table. There are short-term, seasonal, and long-term fluctuations in water level of the Great Lakes. Since the water table is essentially an extension of the Great Lakes, the same kind of fluctuations also occur underground, out of sight. Therefore, the level of the ground water table in any particular place determines to a large degree that place's horizontal distance from open water bodies. All residential structures, access ways, and accessory uses (including sewage disposal systems) should be elevated a safe distance above groundwater. Such a safe distance should be a minimum distance, established from the combined available data from short-term storms, seasonal high water, and long-term climatic cycles.

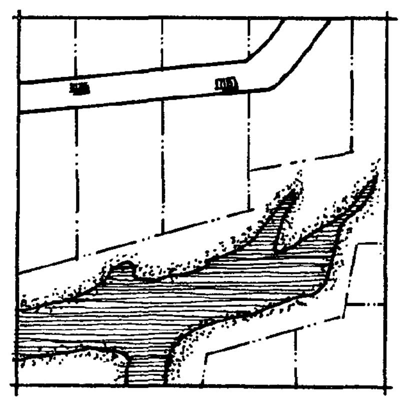
3) protection of wetlands vegetation and fish and wildlife habitat

The Department of Natural Resources has recently undertaken a major study of wetland environmental areas in compliance with the Shorelands Protection and Management Act of 1970. Shoreland wetlands were evaluated as to "prime value for habitat and propagation of wildlife species". Such environmental areas may contain both on-shore and submerged land, and may extend above and below the ordinary high water mark. As a result of this detailed study, 452 miles of the total 2322 miles of Michigan's mainland shoreline have been tentatively designated as wetland environmental areas. There are 271 miles of these environmental areas in private ownership on the mainland of Michigan's two peninsulas, and they are therefore considered to be the most critical from a protection point of view. Another 514 miles of mainland and island shorelines, although not designated as wetland environmental areas, were identified as shorelands of considerable cultural, aesthetic, and ecological values. The state law is currently going through the process of being implemented at county and local levels by the planning for and the enactment of special shoreland zoning ordinances. In the meantime, it is a further recommendation of this guideline handbook not to alter the natural conditions of any wetlands necessary for the maintenance of fish and wildlife. More specifically, it is recommended that structural development, filling, dredging, and the construction of access ways be kept to an absolute minimum--and only in accordance with the set of design, and construction and maintenance considerations set forth below.

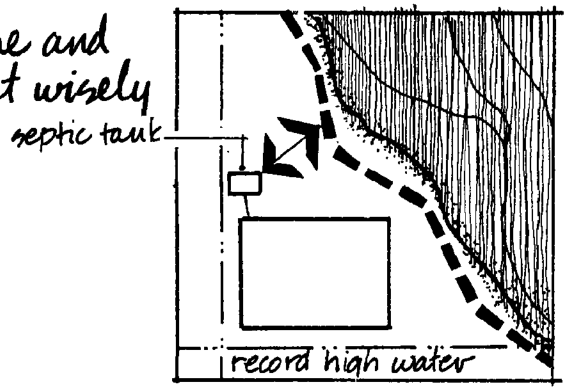
how to design

1) layout of lots on upland

New subdivision lots should have at least a majority of their area in upland, as opposed to wetland. Wetlands may be defined by soils, vegetation, and hydrology/topography - or by a combination of all factors. (The district offices of the U.S. Soil Conservation Service are ready sources of information on wetland soils. Michigan also has state planning and development regions participating in shorelands management programs; fourteen such offices are available sources of information on wetlands. A list of names and addresses may be obtained from the Department of Natural Resources in Lansing.)



lay lots out around wetlands - not on them site structure and disposal unit wisely



2) siting of structures on lots

New residential strucures should be sited as far away from wetland areas as possible, within minimum frontage, setback, and other zoning provisions. Furthermore, each permanent structure should be sited safely above the measurable high ground water table or flood water level of record. As mentioned previously, such a safe distance should be a minimum distance, established principally from the combined available data on seasonal high water and record floods.

3) siting of roads away from

It is recommended that all roads and other access ways in residential areas be sited as far away from wetland areas as possible. A buffer of dry land and vegetation between roadways and wetlands tends to minimize potential pollution. Such pollution results when lead and other heavy metals from petroleum products, as well as nitrates and phosphates from road salt, run off into marshes and swamps where they tend to become concentrated due to accumulation and water evaporation.

4) siting of pathways and trails

Boardwalks for educational and recreational purposes may be laid out in wetland areas if designed above the seasonal high water table. Earthen trails for pedestrians can be laid out simply as extensions of boardwalks through non-wetland areas. Bikeways are better sited in combination with roadways away from wetlands, rather than out over wetlands on boardwalks. However, pathways for bicycles may be designed as separate systems in closer proximity to wetland areas than roads should be.

5) clustering of site development

As previously discussed under sand dunes, the clustering of single-family housing units is a popular alternative to more conventional zoning and subdivision development. Better design and more economies-of-scale are the principal advantages. Cluster residential development is recommended where an especially appropriate site is found, such as a relatively high and dry place with well-drained soils capable of absorbing effluents from septic tanks or other on-site sewage disposal systems.

6) protection of soil, vegetation, and wildlife habitat

Wetland soils, vegetation, and hydrology are among the ecological factors of most significance to fish and wildlife habitats.

Some of the important species of Great Lakes fish to which these wetlands greatly contribute are northern pike and muskellunge, for purposes of spawning, and perch, smallmouth bass, walleye, and channel catfish, for feeding and protection purposes.

Therefore, measures to consider for development include such alternatives as: a) complete avoidance of construction in wetland areas; and b) raised construction in minor portions of wetlands, with a minimum of interference with drainage patterns and flows, exposure to sunlight, and water table elevation.

what to consider in building

1) footings and foundations

Design of footings and foundations in or near wetlands will depend upon specific site conditions, particularly those related to the level of the seasonal high water table and the record high flood level.

Slab foundations are recommended in areas which are subject only to temporary, seasonal water below or near the surface. Where the permanent groundwater level is at or near the surface, more complex construction techniques are called for.

When building on piles in wetlands, it is sometimes advisable to combine pile footings with ground beams for underpinning. Such a case represents generally a wetter site than where only a slab foundation is recommended, but a site that is not so wet that it requires elevated pile footings or "stilts".

In any event, where used, pile footings must penetrate the organic and inorganic wetland soils to solid strata in order to provide a firm foundation.

Stilts or elevated piles are recommended for those structures for which alternative sites are not possible or enforceable, and the locations in which they must be built are subject to seasonal high water--or worse. Structures should be raised well above the record flood level. They can, and ought to be designed architecturally to reflect compatibility with surrounding vegetation and land forms.

2) basements

When basements are constructed in or near wetland areas, special damp proofing, water proofing, and even flood proofing techniques are required.

Basements with floors above the groundwater level must often be protected against dampness and infiltration of rainwater. Where possible, surface waters should be drained away from the structure by sloping the ground surface and conducting the rainwater from downspouts in paved channels. Where necessary, a damp proof coating should be applied to the exterior basement surfaces of the portion of exterior walls below the ground surface to increase their resistance to moisture penetration. Such coatings should seal a wall against the passage of moisture by capillary action, and of water filtering in through minor defects; however, they are not effective in sealing cracks that develop after application.

The portion of a basement below the groundwater level must be designed and constructed to exclude water and to resist the earth and any hydrostatic pressures to which it is subjected. An extensively used method for waterproofing basements consists of providing a continuous bituminous membrane around the portions of the outside walls that are below the groundwater level and on the underside of the basement floor. A wall membrane should be protected against indentation by the backfill and abrasion caused by its settlement by a coat of portland cement mortar, a layer of asphalt-impregnated fiber board, or preferably a single wythe of brick masonry. Before placing a floor membrane, a tamped base of gravel or crushed rock 4 inches or more thick must be provided. A cement mortar or concrete leveling bed at least 1 inch thick is placed on this base to receive the membrane. Finally, a concrete basement floor slab is placed. The membrane must be continuous under all columns, interior walls, and exterior walls; it must also be continuous across the joint between the floor and exterior wall membrane.

Furthermore, the basement wall must be designed to resist lateral earth and water pressures, and the floor to resist any hydrostatic uplift that may develop. Obviously, the basement cannot be excavated nor this récommended procedure carried out if the groundwater cannot be lowered below the basement floor level during the construction period. The only means of doing so is by pumping.

Flood proofing techniques represent the most serious situation with respect to building in wetlands. When flood waters surround a building, they impose loads on the structure and substructure beyond those it normally is designed to withstand. A determination of these loads is a prerequisite of flood proofing efforts, and therefore a professional architect or engineer should be engaged before constructing a dwelling in a flood-prone area.

Groundwater conditions may adversely affect the stability of a structure either through uplift, which tends to "float" the building, or by erosion which can undermine the support. Investigation and analysis of the factors involved at any specific building and the design of control or corrective measures are endeavors requiring the attention of professionally trained personnel.

Groundwater problems can be controlled by the installation of subsurface drainage systems to reduce the lateral forces on the foundation walls and floor slabs. Experience has shown that the composition of soils in a particular area can vary widely, with extreme ranges of permeability existing in areas of the same general geological origin. Such ranges in permeability are further reason for careful investigation and analysis. The design of a subsurface drainage system must be based on the results of soil investigations of permeability and analyses of structural strength.

A sump and pump system can be employed to help protect the subsurface part of a building. The pump could be designed to accept storm and seepage flows and pump them to a point above the flood waters. The sump should be open to the soil at the bottom and to atmospheric pressure at the top within the basement. This would provide a fail-safe feature, in that power or pump failure would allow water to flood the basement and thereby tend to balance the flood induced outside pressures upon the basement walls and floor slab.

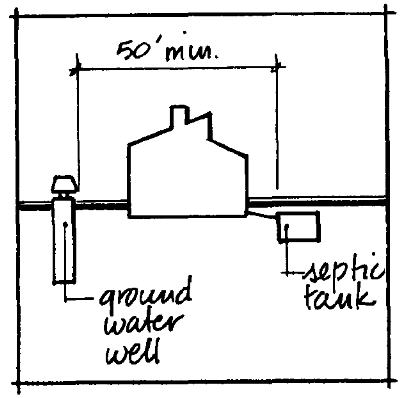
As an alternative, a pre-arranged program of deliberate flooding with clean water could be employed to minimize the cost of clean-up after a flood.

3) utility systems

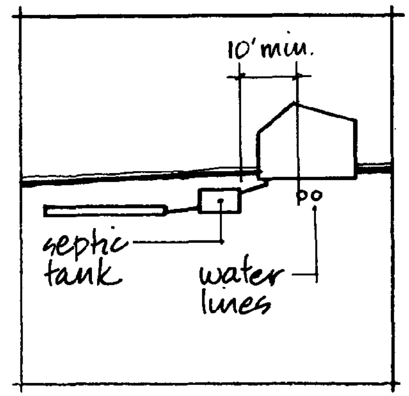
Standards for the installation of water and sewage disposal systems, as well as of other utility systems, are provided for in state, county, and local subdivision rules and regulations, sanitary codes, and building codes. Generally speaking, the following set of figures is accepted in Michigan as minimum isolation distances (in feet):

From:	To: Septic Tank	Leaching Field
Well	50 *	50 *
Water Lines	10	10
Lake or Stream	50	50

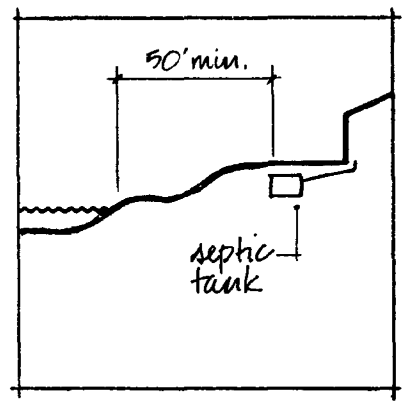
* Seventy-five feet isolation required in all cases except one- and two-family houses.



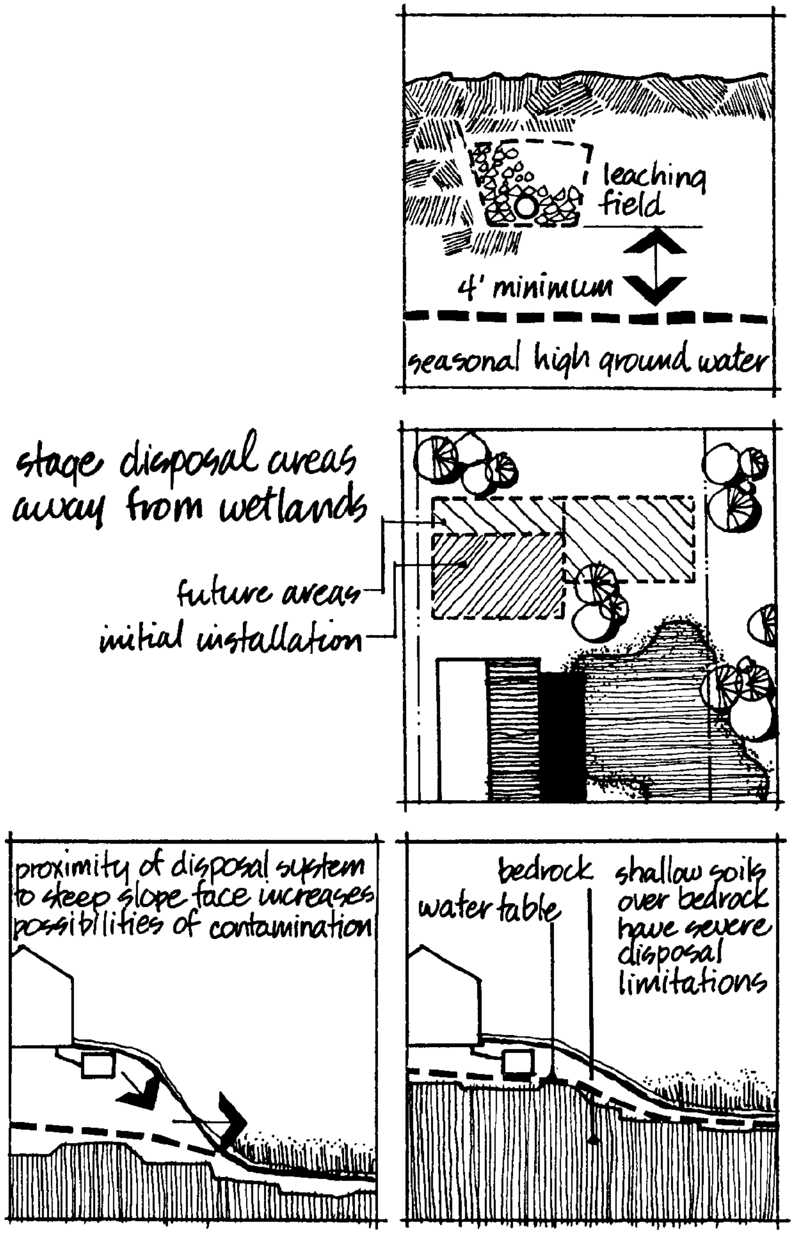
keep sewage disposal systems away from wells



... away from waterlines



... and away from the shore



While each determination as to site suitability for a sewage disposal system must be made in the field with percolation tests and soil borings, the following recommendations are generally valid. Soil permeability should be moderate to rapid, and the soil percolation rate should not exceed 30 minutes per inch for absorption fields and 60 minutes per inch for absorption beds, dry wells, seepage pits and block trenches. Groundwater level during the wettest season should be at least 4 feet below the bottom of the trenches in a subsurface-tile absorption field and 4 feet below the pit floor in a field using seepage pits. Obviously the last guideline may require proper utilization of elevated or mounded systems in accordance with local rules and regulations, including required inspections by the health officer or sanitarian. Private sewage disposal systems require periodic maintenance and service. For future replacement purposes, at least 2½ times the area required by the percolation test for the initial installation is recommended to be available on the existing lot. Trenches and seepage beds are difficult to lay out and construct on slopes steeper than 15%; subdivision lots with slopes of between 12-25% create severe limitations for development. If steep shallow soils that are underlain by rock or other impervious material are used as absorption fields, the septic tank effluent is likely to seep to the a private well or water body. Obviously, sewage disposal systems should not be set uphill and within close range of wells and water bodies; distances for uphill sites should definitely exceed the minimum setback required under law.

4) road foundations

In order to prevent freezing and thawing in road foundations from causing frost heaves and eventual cracking and breaking of pavement, the road base should be built to a greater depth than that required for well-drained sites.

This construction measure tends to establish good internal drainage in road foundations, thus helping to get rid of water lying on the pavement or otherwise available for the damaging effects of the freeze/thaw cycle.

When new roads are actually constructed in wetlands, it is important to dredge out all organic soils in order to avoid sinking and cracking of pavement at a future date.

Non-paved roads are obviously useful in or near wetland areas; they allow the rainfall to percolate back into the ground water system as quickly as possible. Also, possible adverse effects of dumping the excavated organic soils in other locations are avoided.

Even more environmentally desirable is the use of wooden bridge sections or timber causeway sections on permeable sub-grade. Such solutions, although more costly in construction, may prove cost-saving in the long run if the surface roads in question would be subject to frequent wash-outs and reconstruction outlays.

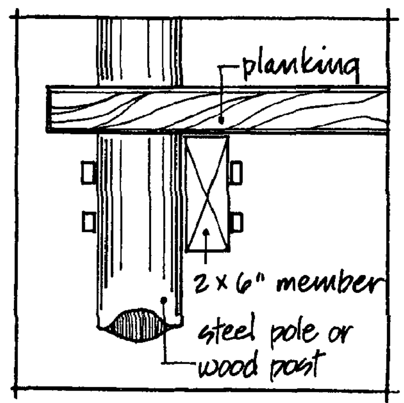
5) boardwalks

In order to avoid the disruptions of wetland drainage patterns and ecology that often result from the emplacement of fill used for on-grade road and path construction, boardwalks should be used for pedestrian passage where needed, wherever possible. In some cases, boardwalks may be made sufficiently wide and strong to support vehicular as well as pedestrian use.

Where water levels are periodically at or above gound-level, boardwalks should be of the raised type, which leaves adequate clearance for surface drainage beneath. On ground which is only rarely flooded at the surface, the on-grade type of boardwalk will serve.

For both types, wood posts or steel poles should be sunk into the hardpan or solid ground below the water level at 10 to 12 foot intervals. Two inch by six inch planks of the required lengths should be bolted to the posts, running with the path, with 4-foot boards nailed cross-wise over the planks and 1/2 inch spacing between boards. Handrails made of heavy rope and 1/2-inch stripping on the sides of the boardwalk complete the project. As with all other surface paths, on-grade boardwalks should incorporate drainage passages to allow water to flow underneath without significant impairment.

In certain special cases, non-permanent floating boardwalks or other floating accessory structures, such as piers or docks, are recommended where appropriate.



boardwalk detail

conclusion

The problems created by haphazard development in Michigan's sand dunes and wetlands are serious ones for both the landowner, whose property it devalues, and the public, for whom these priceless shore resources are a unique part of Michigan's outdoor heritage. The challenge is a difficult one for the property owner. In many cases, the best course of action would be not to build at all, or to build as remotely as possible from the shore, in order to protect the land both as personal property and as a natural resource. But the enlightened owner can use simple guidelines--such as those presented in this booklet--as well as common sense and carefully selected professional guidance to avoid many site planning and design pitfalls.

Remember--if you must build a structure or a path in a sensitive shoreland area, build it as far away from the shore, dune crests, and wetlands as possible. The result may not be as close to the water as it might, but it will have a far better chance of lasting longer--and may become a more attractive element of the landscape as well.

For further information, contact the Water Development Services Division, Michigan Department of Natural Resources, Lansing.

recommended reading

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Water Development Services Division
Michigan Department of Natural Resources/Lansing, Michigan

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